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Self-Leveler for Tobacco Farm Tractor-Loaders

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CONTENTS

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By Elmon E. Yoder[1]

ABSTRACT

This report describes a procedure for constructing and installing a mechanical self-leveling device on commercially manufactured farm tractor-loaders used for handling harvested stalk-cut tobacco plants on portable curing frames. The mechanism automatically keeps tines level while a curing frame is being raised or lowered. Index terms: farm tractor-loaders, self-leveling linkages, tobacco-curing frames.

INTRODUCTION

A procedure was previously developed for handling harvested stalk-cut tobacco plants on portable curing frames with a farm tractor-loader fitted with tines; this procedure, along with equipment modifications, is described in USDA Agriculture Information Bulletin 366, "Handling Burley Tobacco on Portable Curing Frames." Figures 1-6 illustrate filling the portable curing frames with hand-cut tobacco (fig. 1), filling the frames directly from a tobacco harvester (fig. 2), field-wilting tobacco on the frames before housing (fig. 3), transporting the frames of tobacco to the curing barn (fig. 4), housing the frames of tobacco with a loader (fig. 5), and removing cured tobacco from the frames for stripping (fig. 6).

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FIGURE 1

FIGURE 2

The advantages of this system over the conventional manual method are reduced labor requirements and easier and safer work. A conventional tractor-loader capable of lifting 1,500 pounds to a bucket-pin height of 9 feet, which should be the manufacturer's minimum specification requirement and one that is common for tractor-loaders, can be used to handle the curing frames if the bucket (fig. 7) is replaced with tines and safety masts (fig. 8). This inexpensive conversion can be more convenient for the tractor operator if the tines are controlled by a self-leveling mechanism.

This report is a guide for constructing and installing such a device on commercially manufactured farm tractor-loaders that have dump cylinders similar to that shown in figure 7, where positive hydraulic pressure in the rod end of the dump cylinders carries the load. Specific dimensions for the self-leveling linkages are not included because

FIGURE 3

FIGURE 5

FIGURE 4

FIGURE 6

pin locations and dimensions of frame members are not uniform among loader manufacturers. The illustrations give a general procedure for determining pin locations of the self-leveling linkages, attaching hardware to the loader, and constructing the linkages. Loader owners who plan to install a self-leveling device should first check the warranty restrictions specified by the loader manufacturer.

The author suggests that loaders similar to that described in this report be operated only after a safety roll cage has been installed on the tractor. The roll cage should extend a sufficient distance in front of the operator to give protection against a load falling rearward from the tines. This protection is in addition to that provided by the vertical safety masts installed at the rear of the tines. To give clarity to the photographs used in this report, a safety roll cage was not installed.

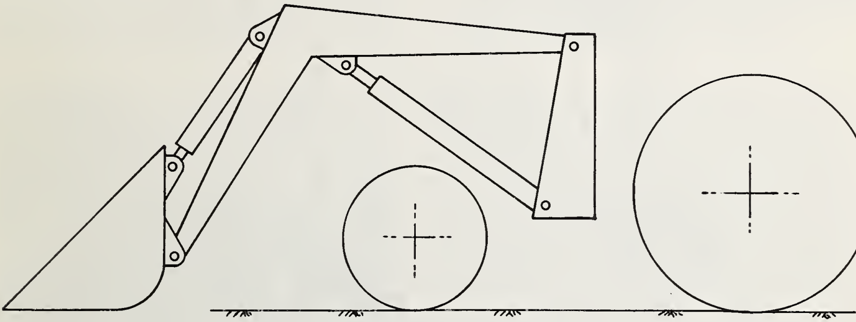

FIGURE 7

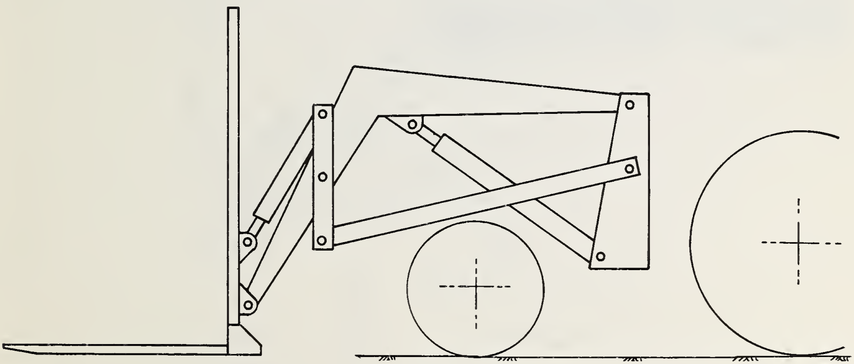

FIGURE 8

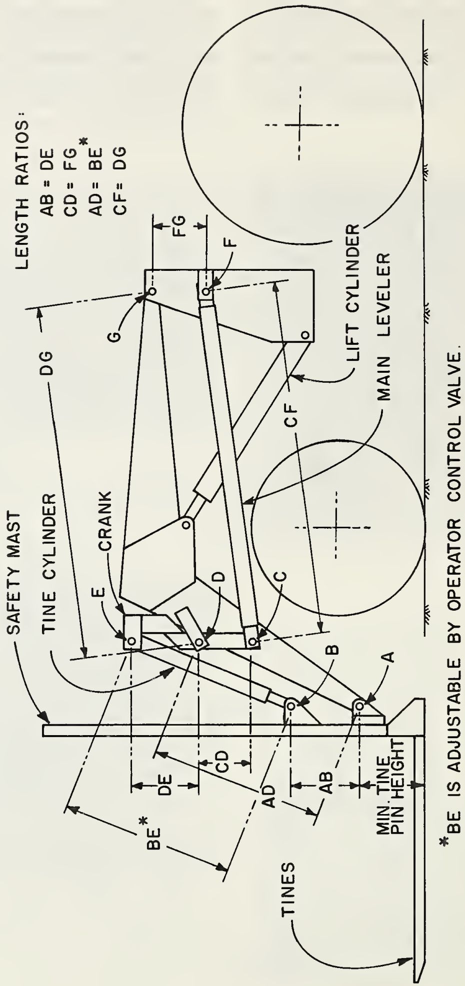
LENGTH RATIOS:
AB = DE
CD = FG
AD = BE*
CF = DG
SAFETY MAST
TINE CYLINDER
CRANK
E
D
C
B
A
G
F
FG
DG
CF
LIFT CYLINDER
MAIN LEVELER
DE
CD
AD
AB
MIN. TINE PIN HEIGHT
BE*
TINES
*BE IS ADJUSTABLE BY OPERATOR CONTROL VALVE.

FIGURE 9

The self-leveling device consists of two interconnected parallel-linkage mechanisms that are duplicated on each side of the loader (fig. 9). The tine cylinder, which has an adjustable center-to-center pin length equal to BE, and the main-leveler member, which has a fixed center-to-center pin length equal to CF, form active links to the two parallel linkages. The two linkages are shown in figure 9 as ABED and CDGF. The tines will become level when the operator adjusts the tine-cylinder control valve so that adjustable pin length BE is equal to fixed pin length AD. During this condition, the tines will automatically remain level while the load is being lowered (fig. 10) or raised (fig. 11). The operator may at any time tilt the tines either up or down to a selected inclination by adjusting the tine-cylinder control valve. The tines will then remain at that approximate inclination while the load is being raised or lowered. It is essential to the performance of the self-leveler that the length of the links and the location of the pins accurately conform to the ratios specified in figure 9.

FIGURE 10

FIGURE 11

The layout procedure for determining the length of links and for locating the pins (figs. 12-15) is an alternative to preparing a layout on a drafting table. It involves temporarily clamping 1- by 3-inch wooden layout boards to the unmodified loader (fig. 12) to simulate the self-leveling linkages (figs. 13-15). This "on the tractor" layout method requires a trial selection for the location of pin F (fig. 9). The layout boards are then positioned on the loader so that the linkage-length ratios specified in figure 9 will exist when the bracket for crank pin D is located for convenient welding to the loader frame. A successful layout requires accurate positioning and careful clamping of the layout boards. The following step-by-step procedure is given for locating the linkage pins identified in figure 9:

1. Mark a centerline along the face of each of five layout boards having lengths approximating those shown in figures 13-15.
2. Position the tractor on level ground (fig. 12).
3. Select a minimum tine-pin height to establish pin location A; this should be as low as possible. Usually, there will be inadequate space for installing the main leveler to pass between the front tire and the tractor frame. Therefore, the main leveler must usually pass over the front tire, as shown in figures 13-15 where the minimum tine-pin height for pin A was selected as 12 inches. Any first selection for minimum tine-pin height may later need to be changed to comply with the pin locations selected during the next steps.
4. Select first-trial center-to-center pin distances for linkage ratios AB=DE and CD=FG. In the examples shown in figures 13-15, the distances selected were AB=DE=13 inches and CD=FG=12 inches. Avoid a layout resulting in any of these linkages being shorter than 10 inches because shortening linkages increases the loads on the pins and links.
5. Completely retract the dump cylinders on the loader and measure center-to-center pin distance BE. In the example, this distance was 26⅜ inches (fig. 13).
6. Drill a ¼-inch hole through the centerlines of the four layout boards that represent pin distances AB, DE, CD, and FG to identify pins A through F. These holes must be accurately spaced, that is, within one thirty-second of an inch of the distances selected or measured in steps 3, 4, and 5. (Do not drill holes at this time in the main-leveler layout board, which represents pin distance CF.)
7. Install ¼-inch bolts at pins B and E to connect the tine-cylinder layout board to the safety-mast layout board and the crank layout board.
8. Clamp the four boards to the loader (fig. 13), so that—
   (a) The center of leveler pin F is vertically below the center of loader pin G.
   (b) The center of tine pin A is accurately alined with the center of the bucket pin on the loader.
   (c) The crank layout board is vertical.
   (d) Crank pin D is precisely located to insure that center-to-center pin distance AD is equal to center-to-center pin distance BE of the retracted dump cylinder and that the crank-pin bracket at pin location D can be conveniently welded to the side of the loader frame.
   (e) The safety-mast layout board is tilted back towards the tractor at least 15° when the center of rod-end cylinder pin B is at least 2 inches from a string stretched between the centers of tine pin A and cylinder pin E.
   (f) A string stretched between the centers of main-leveler pins C and F has at least 3½ inches of clearance over the front tire.
9. Measure the center-to-center distance from crank pin D to loader pin G, and measure the center-to-center distance from leveler pin C to leveler pin F. The measured distance for DG should be within one-sixteenth of an inch of that measured for CF. In the example (figs. 13-15), both of these distances were 73⅛ inches.
10. Remove the ¼-inch bolt from the layout boards at rod-end cylinder pin B, and loosen the clamp to the safety-mast layout board. Then rotate the safety-mast board about tine pin A until the board is vertical. Retighten the clamp and check to make sure that the mark on the board for tine pin A is still accurately alined with the hole in the loader.
11. Measure the new distance on the layout boards between the centers of cylinder pins B and E. This is tine-cylinder pin spacing BE

FIGURE 12

FIGURE 14

FIGURE 13

FIGURE 15

when the tines are level; in the example shown in figure 14, this was 27¼ inches. Re-mark the tine-cylinder layout board and rebolt it to the loader. Now relocate crank pin D so that center-to-center pin spacing AD is equal to the new BE spacing when both AB and CDE are vertical.

12. Recheck the center-to-center pin distances for DG and CF; they should still be the same as in step 9. Drill ¼-inch holes through the centerline of the main-leveler layout board and bolt it to the loader. The clearance between the bottom of the layout board and the top of the front tire (fig. 14) should be at least 2½ inches.
13. Recheck the location and position of the layout boards to make sure that linkage ratios, linkage clearances, and pin locations are satisfactory. Revise the locations of main-leveler pin F and tine pin A if the first-trial selection results in more than 4 inches vertical clearance between the main leveler and the front tire.
14. Revise pin locations as many times as necessary while setting up the layout boards so that all clearances and linkage ratios are satisfactory. The layout procedure is complete when all the above requirements are met. Before removing the layout boards, determine the location of the center of crank pin D, shown in figure 15, by recording accurate measurements to reference points on the loader frame. The reference points can be the center of tine-pin hole A and the upper face of the loader frame. It is essential that the location of the crank-pin bracket at D be accurately reestablished on both sides of the loader after the layout boards are removed.

(*Continued on page 8.*)

The layout in step 8 simulates the loader linkages when the tines are on the ground and are tilted upward at maximum inclination. It is important to initially locate the layout boards with the tine cylinder retracted, as previously described, so that the tines cannot be tilted upward at a greater angle when the loader is raised than is permitted when the loader is lowered. That is, crank pin D in the example was finally located so that when the tine cylinder was extended three-fourths of an inch the tines were level and the linkage length ratios were as specified in figure 9. If this precaution is not observed in the layout, excessive hydraulic pressure can be introduced into the hydraulic system while the loader is being lowered.

CONSTRUCTION AND INSTALLATION

The exact dimensions for the parts to the self-leveler described in this report are only partially listed because loaders are manufactured in a variety of sizes and are of nonuniform design. Thus, it is likely that some of the parts to be installed on other loaders of different design would have to be constructed to slightly different specifications. Figures 16-31 illustrate the self-leveler as installed on one particular model and are included to clarify the instructions and serve as a guide in planning minor changes that may be required for other loaders.

The structural metal used in making the self-leveler may be hot-rolled mild steel. The clevis at all pin locations should be so constructed that total wall clearance between the interior faces of the clevis and the tongue or inserted member is not less than one-sixteenth of an inch nor more than one-eighth of an inch. It is important that the pins be accurately installed at the locations that were determined by the layout boards. The linkage pins may be 1-inch (o.d.) cold-rolled mild steel. All holes to receive the pins should be one thirty-second of an inch oversize, that is, $1\frac{1}{32}$-inch (i.d.) holes for 1-inch (o.d.) pins. All pins should be securely locked in place. The dump cylinders (fig. 7) installed by the manufacturer are removed from their original mount and reinstalled as tine cylinders on the self-leveling crank (fig. 9). It is likely that some of the originally installed hydraulic hoses will need to be replaced with longer hose.

All construction and installation welds should be all-around welds. During construction, all members should be initially installed with secure tack welds. The tack welds are completed as all-around welds only after careful observations for satisfactory pin locations, accurate alinement of clevis and tongue holes, and adequate clearances.

The rear clevis bracket of the main leveler (figs. 16 and 17) at pin location F (fig. 9) is made of $\frac{3}{8}$- by $2\frac{1}{2}$-inch flat bar. This clevis bracket should be sufficiently offset from the side of the loader frame to give the main leveler not less than one-half inch clearance to the loader frame. This is shown in the typical installation (figs. 16 and 17), where the gusset serves as a spacer for clearance and also as structural reinforcement to the loader frame near the bracket. The main leveler should be made of square tube having a minimum size of $\frac{1}{4}$- by 3- by 3-inches. The tongue should be made from 1- by $2\frac{1}{2}$-inch flat bar that is inserted about 2 inches into the tube and then securely welded. The distance from the $1\frac{1}{32}$-inch (o.d.) hole through the clevis to the heel of the clevis should not be greater than required for clearance between the end of the leveler tongue and the heel.

FIGURE 16

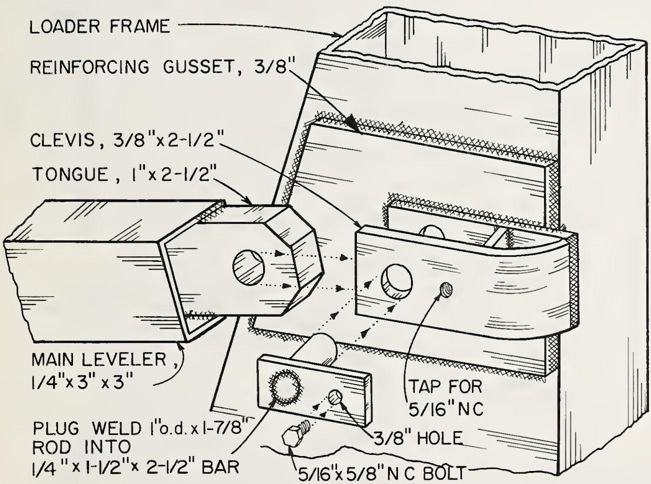

FIGURE 17

FIGURE 18

The clevis at the front of the main leveler at pin location C (fig. 9) is made of ⅜- by 2½-inch flat bar that is inserted into the leveler tube about 2 inches and then securely welded (figs. 18 and 19). The distance from the end of the ¼- by 3- by 3-inch leveler tube to the hole in the clevis should not be greater than required for clearance to the rear edge of the crank. The 1-inch (o.d.) pin must penetrate the full width of the clevis when secured with the locking bolt.

The crank clevis at pin location D (fig. 9) is made of ⅜- by 2½-inch flat bar. The clevis should be welded to a gusset (figs. 20 and 21) to obtain required clearance between the leveler and the loader and to reinforce the loader frame near the clevis. The center of the 1¹⁄₃₂-inch (o.d.) hole should be 3½ inches from the heel or backface of the clevis. The clevis should be welded to the gusset at a 30° angle (fig. 21) while the loader is in the lowered position (fig. 9). The 30° inclination is suggested to insure clearance between the edge of the crank and bottom edge of the heel of the clevis when the loader is in the raised position (fig. 11). Particular care must be taken to install the crank pin at location D, as determined by the layout boards.

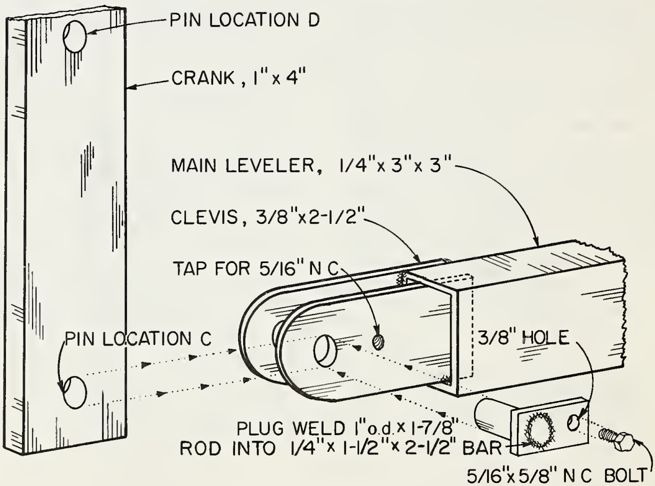

FIGURE 19

FIGURE 20

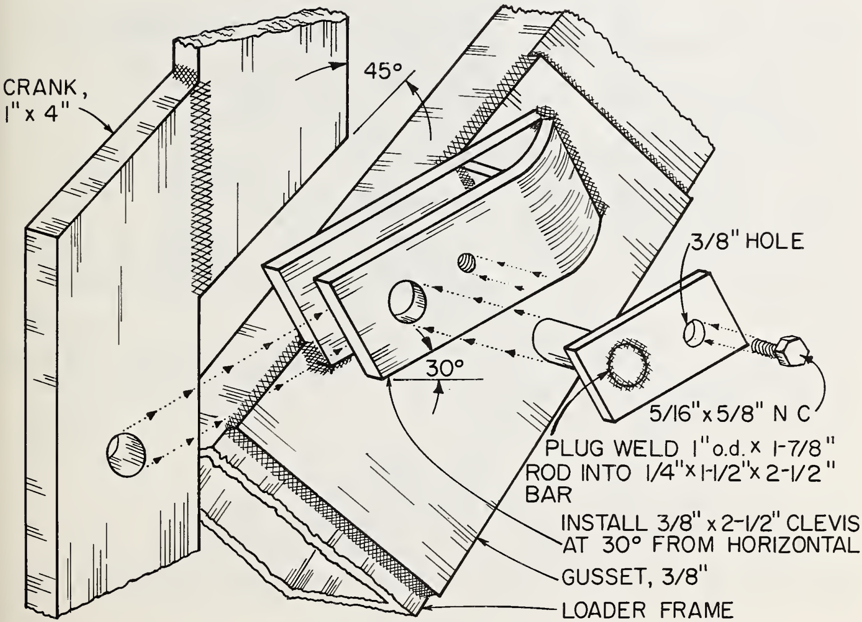

FIGURE 21

FIGURE 22

The crank is made of 1- by 4-inch flat bar. It is essential that the three $1^1/_{32}$-inch holes be drilled along a straight line. This alinement can be obtained by making a 45° cut across the face of the bar and then rejoining the two pieces by lap welding along the edge (figs. 22 and 23). The example shows a clevis made from ⅜- by 2½-inch flat bar that is welded to the top of the crank at location E. In this case, it was necessary to cut off a small amount of material from the crank at the upper corner of the joint to give adequate clearance to the cylinder barrel. The dump-cylinder pin that was originally installed by the manufacturer may be used to install the tine cylinder at location E.

The tine assembly must be equipped with safety masts (figs. 24-27). The masts consist of two vertical steel members that are securely welded to the tines. They serve as a convenient "stop" for the loader when the tines are being inserted under a

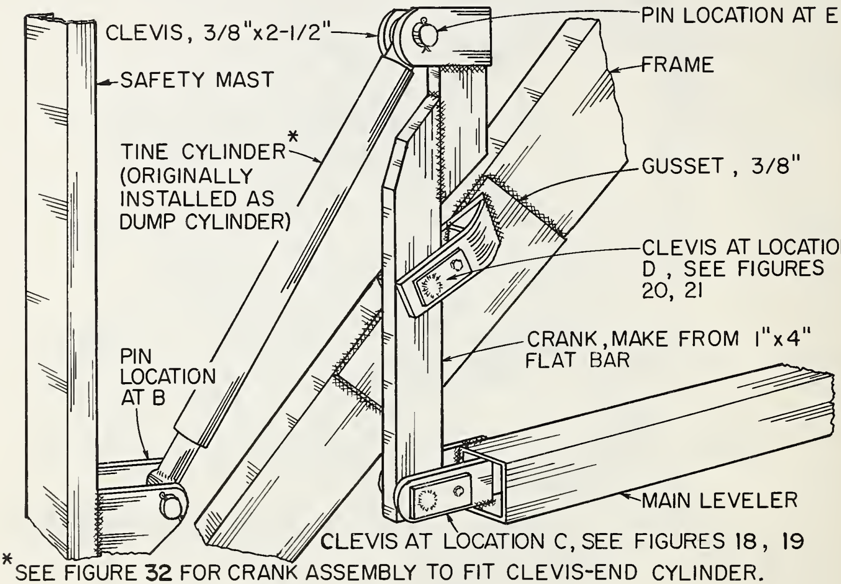

FIGURE 23

tobacco-curing frame. They also serve as an important safety device to prevent accidental rearward movement and rearward tipping of the load on the tines.

The tines and safety masts may be made of standard 6-inch channel (8.2 lb/ft). To comply with the dimensions of the portable curing frame described in USDA Agriculture Information Bulletin 366, the tines should extend 52 inches past the front faces of the safety masts. The tops of the masts should extend 68 inches above the top faces of the tines. A ⅜-inch steel-plate gusset should be installed as shown in figures 24-27 to reinforce the weld that secures the tines to the masts. The rear 30 inches of each tine and the lower 30 inches of each mast should be "boxed" with a ⅜- by 5½- by 30-inch reinforcing plate (figs. 25 and 27). The outer face of this reinforcing plate should be

FIGURE 24

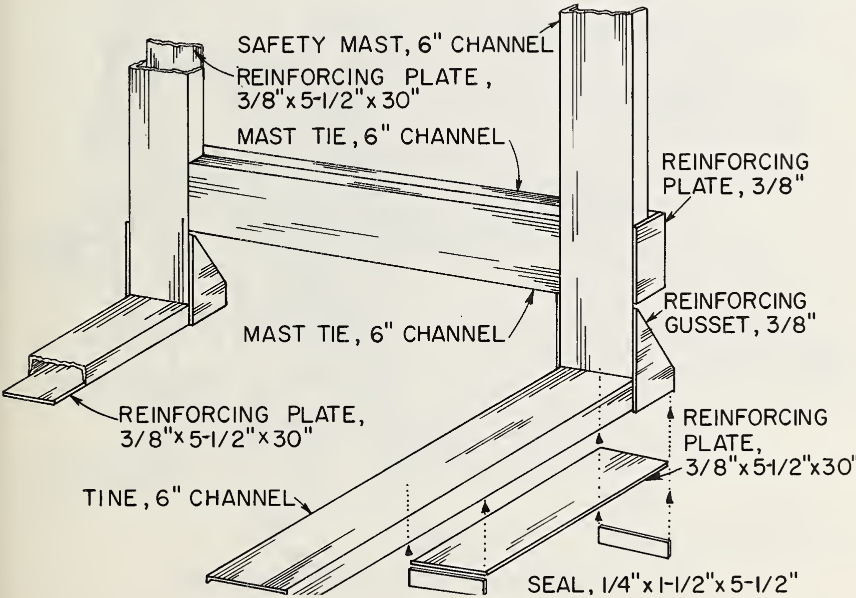

FIGURE 25

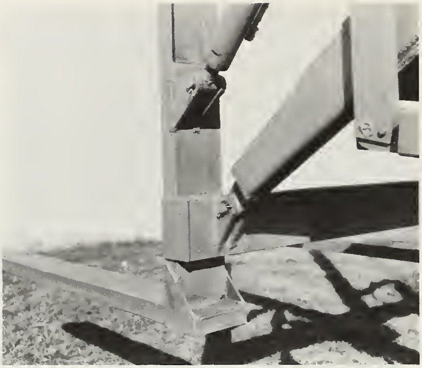

FIGURE 26

welded flush with the lip of the flange. Ends of the "boxed" channels may be sealed with ¼- by 1½-inch bars. The tine spacing selected is a dimension that is convenient for installing the tine clevises to the safety masts (figs. 28 and 29). Two 6-inch channels may be welded flange-to-flange to form a rectangular tie-member for joining the two safety masts (figs. 24-27). The forward channel of the rectangular tie-member should be 12 inches shorter than the rear channel to allow the ends of the forward channel to be butt-welded to the inner flanges of the safety mast. The rear channel should extend flush to the outer flanges of the mast.

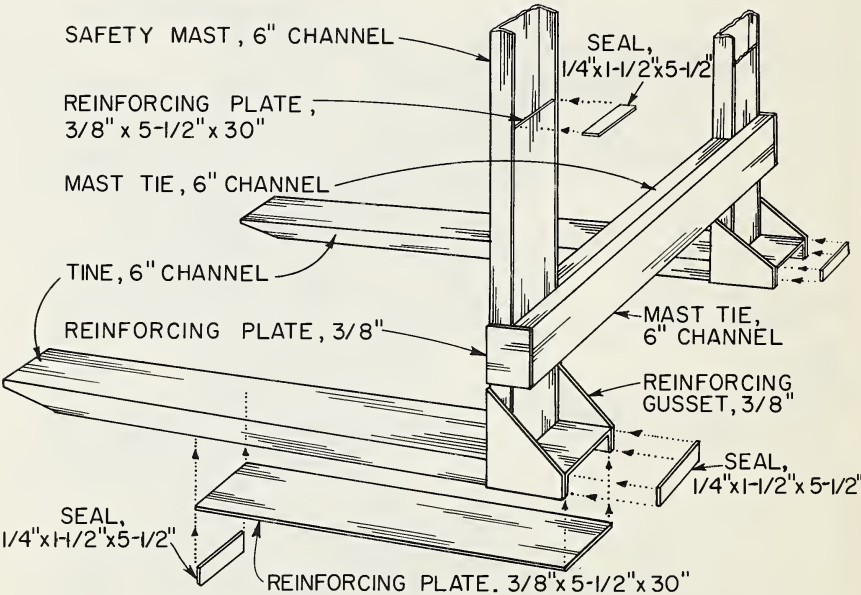

FIGURE 27

A ⅜- by 4- by 6-inch steel plate at each end of the rectangular tie-member serves as a seal to the rear channel and also as a reinforcing gusset.

The clevis at tine-pin location A (fig. 9) is made of ⅜-inch steel plate. It is welded (figs. 28 and 29) to the web of the rear 6-inch channel that forms the boxed tie-member between the two safety masts. The center of the clevis hole should be located at a distance from the web of the rear channel that will provide only minimum clearance between the tongue and the web. The bucket pin that was originally installed by the manufacturer may be used again at location A.

FIGURE 28

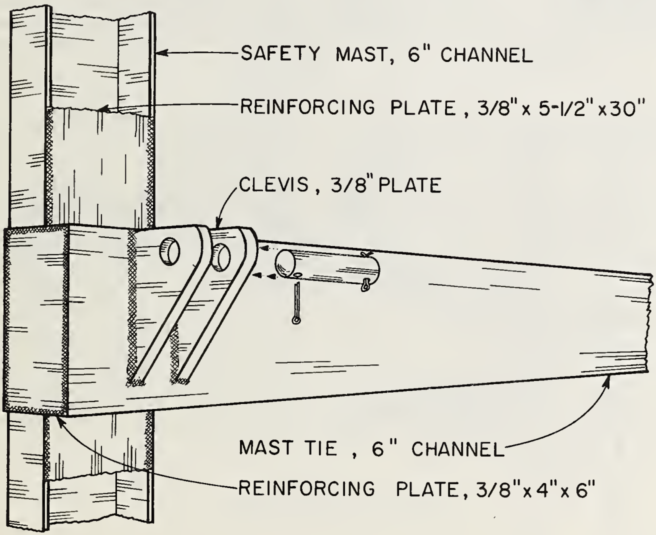

FIGURE 29

FIGURE 30

The clevis at tine-cylinder pin location B (fig. 9) is made of ⅜-inch steel plate. It is welded (figs. 30 and 31) to the ⅜- by 5½- by 30-inch steel plate "boxing" of the safety masts. The reach of this clevis must be about 2 inches longer than the clevis at location A, so that when the tines are level the center of pin B will be vertically alined with the center of pin A. The dump-cylinder pin that was originally installed by the manufacturer may be used to install the tine cylinder at location B.

Clevis-end dump cylinders are frequently installed by loader manufacturers. The steel-plate tongues for the self-leveler at pin locations B and E (fig. 9) should then be constructed similar to those shown in figure 32. The tongue at location B should also be constructed similar to the clevis shown in figures 30 and 31. The interior width of the cylinder clevises is usually 1⅛ inches, so the 1-inch tongues will be satisfactory for these clevises. The crank must be constructed so that the center of the holes at pins C, D, and E are located along a vertical

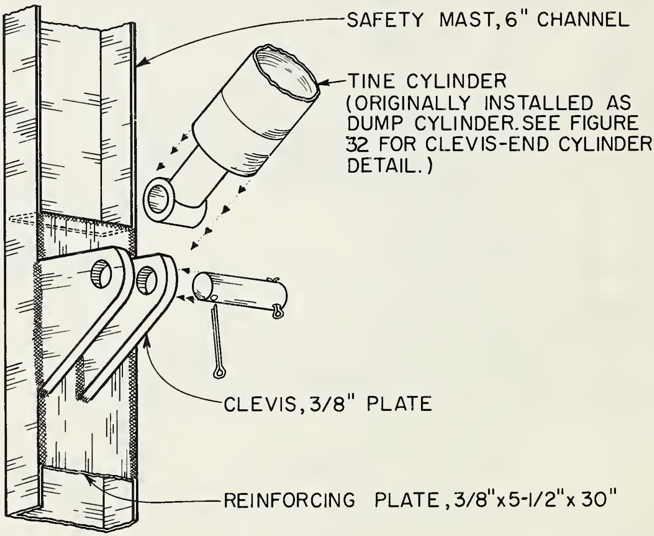

FIGURE 31

line. This alinement can be obtained by offsetting the upper portion of the crank as shown. The offset in the 1- by 4-inch crank must be constructed so that there is clearance between the cylinder and the forward edge of the crank and between the heel of the clevis at pin location D and the rear edge of the crank. Also, the reach of the tongue at location B must be sufficient to locate the center of the hole vertically above the center of the hole at location A when the tines are level.

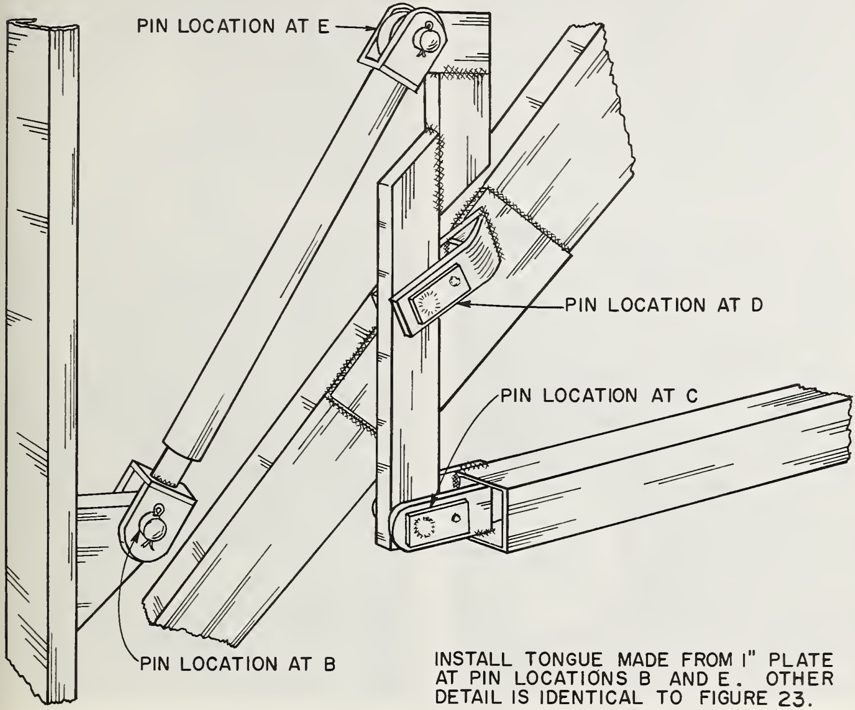

FIGURE 32

Pin locations, pin-clevis alinement, and clearances should be carefully checked before and after the all-around welds are completed. These checks should be made throughout the full range of loader movement. As shown in figure 33, the vertical clearance between the bottom of the main leveler and the top of the front tire should be not less than 2 inches when the tines are resting on level ground. Then, while the loader is lowered and with the tine cylinder completely retracted (fig. 34), the center of the tine-cylinder pin at location B (fig. 9) should be offset at least 2 inches from a string stretched between the centers of pins A and E. The tines should be inclined upward not less than 15° when the cylinder is completely retracted. At this time, the clearances between the crank and the tine cylinder and between the crank and the crank clevis should be checked. Then slowly raise the loader with tines level while continuously checking for clearances and for binding between the pins, tongues, and clevises. The tines will remain level throughout the lift if the pins were located as specified in this report. The hoses to the tine cylinder should be free of tension or sharp bends (fig. 35). Also, the finished welds should be carefully checked for stress cracks (fig. 36).

FIGURE 33

FIGURE 34

FIGURE 35

FIGURE 36

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